Absorptive Capacity:
Antecedents, Models and Outcomes

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ERIM REPORT SERIES *RESEARCH IN MANAGEMENT*	
ERIM Report Series reference number	ERS-2003-035-STR
Publication	April 2003
Number of pages	54
Email address corresponding author	hvolberda@fbk.eur.nl
Address	Erasmus Research Institute of Management (ERIM) Rotterdam School of Management / Faculteit Bedrijfskunde Rotterdam School of Economics / Faculteit Economische Wetenschappen Erasmus Universiteit Rotterdam P.O.Box 1738 3000 DR Rotterdam, The Netherlands Phone: + 31 10 408 1182 Fax: + 31 10 408 9640 Email: info@erim.eur.nl Internet: www.erim.eur.nl

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Library of Congress Classification (LCC)	5001-6182	Business
	5546-5548.6	Office Organization and Management
	T 58.6-58.62	Management information systems
Journal of Economic Literature (JEL)	M	Business Administration and Business Economics
	L 20	Firm Objectives, Organization and Behavior: general
	L 15	Information and product quality; standardization and compatibility
European Business Schools Library Group (EBSLG)	85 A	Business General
	270 A 100 G	Strategic Management Organizational Growth
	270 Q	Information management
Gemeenschappelijke Onderwerpsontsluiting (GOO)		
Classification GOO	85.00	Bedrijfskunde, Organisatiekunde: algemeen
	85.10	Strategisch beleid
	85.20	Bestuurlijke informatie, informatieverzorging
Keywords GOO	Bedrijfskunde / Bedrijfseconomie	
	Strategisch management, organisatievernieuwing	
	Informatiebehoefte, kennis, absorptie, innovatie	
Free keywords	Absorptive Capacity, Knowledge, Innovation	

Absorptive Capacity: Antecedents, Models and Outcomes *)

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FINAL VERSION JANUARY 22, 2002

*) This research was funded by a "Payment to a Centre of Excellence" awarded by the Royal Dutch/Shell Group and is a part of the research program of the Erasmus Strategic Renewal Centre (ESRC) and of the Erasmus Research Institute of Management (ERIM). We would like to thank Erik J. de Boer and Ancella de Boer for their able research assistance.

Abstract

This chapter focuses on the gap between the speed of proliferation of theoretical and empirical contributions and the speed of accumulation of the acquired scientific knowledge regarding absorptive capacity. To contribute to narrowing this gap, we will in particular review the *conceptual* developments of the absorptive capacity construct. Based on the seminal contributions of Cohen & Levinthal (1989, 1990) we will provide a brief overview of the various conceptual attributes of this construct, like the definition, antecedents and consequences, and levels of analysis involved. Next, we will assess the refinements, extensions and reconceptualizations of this construct in the literature. Furthermore, from the perspective of viewing models as mediating instruments between theory and empirical phenomena (Morgan and Morrison, 1999), we will analyze efforts to build conceptual models. Finally, we will address the progress made, select key problems and we will formulate future research directions to improve the *multilevel* and *transdisciplinary* characteristics of absorptive capacity.

1. Introduction

Absorptive capacity is defined as the ability to recognize the value of new external knowledge, assimilate it, and apply it to commercial ends (Cohen and Levinthal, 1990). Key antecedents discerned influencing absorptive capacity are both prior related knowledge (including basic skills and learning experience) and organizational factors, such as the structure of communication and distribution of knowledge. Several social science disciplines like psychology, sociology, economics and political science may contribute to the understanding of how these key antecedents influence absorptive capacity. Absorptive capacity is, therefore, potentially a powerful *multilevel* and *transdisciplinary construct.* In both theory building and empirical research, therefore, this construct is in principle able to bridge and to enrich various related literatures, such as organizational learning and the knowledge based view of the firm.

We will point out, however, that there is a *gap* between the speed of proliferation of theoretical and empirical contributions and the speed of accumulation of the acquired scientific knowledge regarding absorptive capacity. Efforts aimed at recognizing and narrowing this gap deserve more attention. To contribute to narrowing this gap, we will in particular focus on *an overview of the conceptual developments*. This chapter is, therefore, structured as follows (see Figure 1). First, based on the seminal contributions of Cohen & Levinthal (1989, 1990) section 2 provides a brief overview of the various conceptual attributes of this construct, like the definition, antecedents and consequences, and levels of analysis involved. Second, we assess the refinements, extensions and reconceptualizations of this construct in the literature. Third, from the perspective of viewing models as mediating

instruments between theory and empirical phenomena, we will analyze efforts to build conceptual models. Finally, in section 5 we address the progress made and select key problems. We will formulate future research directions to improve the multilevel and transdisciplinary characteristics of absorptive capacity.

[Insert Figure 1 about here]

2. Absorptive capacity construct: definitions, antecedents, and organizational outcomes

The absorptive capacity construct evolved from prior research in the eighties, for example regarding the role of R&D in firm performance and organizational learning (Fiol and Lyles, 1985; Hedberg, 1981; Levitt and March, 1988). Another example is Kedia & Bhagat (1988) who already used the term "absorptive capacity" in the context of technology transfers across nations. We will limit ourselves here, however, in particular to the contributions of Cohen & Levinthal (1989, 1990). They introduced the term of a firm's "learning" or "absorptive capacity" (Cohen & Levinthal, 1989:569) and proposed to consider prior related knowledge as a key antecedent. By doing so, this section provides a kind of template that will be used to assess the contributions of subsequent research on absorptive capacity in the next sections.

Definitions and levels of analysis

As Cohen & Levinthal (1989, 1990) coined the term "absorptive capacity" (Lane & Lubatkin, 1998: 463) it makes sense to start with their definition and to focus in the next section on extensions or reconceptualizations of their definition. Cohen & Levinthal (1989, p. 569-570) introduced the absorptive capacity construct as follows: "the firm's ability to

identify, assimilate and exploit knowledge from the environment". In their widely cited paper in Administrative Science Quarterly, Cohen & Levinthal (1990:128) defined a firm's absorptive capacity as: "… an ability to recognize the value of new information, assimilate it, and apply it to commercial ends." Although in this definition the emphasis is on new information, and information is not the same as knowledge (Boisot, 1998), on the same page Cohen & Levinthal (1990:128) refer to absorptive capacity as follows: "… the ability to evaluate and utilize outside knowledge…". We therefore suggest to use the following definition of absorptive capacity as a firm level construct: *the ability to recognize the value of new external knowledge, assimilate it, and apply it to commercial ends*.

This definition introduces *three capabilities*: (1) recognizing the value, (2) assimilating and (3) applying new external knowledge to commercial ends. These three capabilities have been labeled as components or dimensions of absorptive capacity. For example Lane, Salk and Lyles (2001) distinguish three components of absorptive capacity and each of these components refers to one of the three capabilities mentioned above. Zahra and George (2001) use the term dimensions of absorptive capacity, like Lane and Lubatkin (1998), to distinguish the three capabilities involved in absorbing new external knowledge.

In discussing their definition of absorptive capacity, Cohen and Levinthal (1990:131) pointed out two important issues: (1) the level of analysis and (2) the impact of the organizational context on absorptive capacity by emphasizing that: "an organization's absorptive capacity will depend on the absorptive capacity of its individual members", however a firm's absorptive capacity is not "… simply the sum of the absorptive capacity of its employees, and it is therefore useful to consider what aspects of absorptive capacity are distinctly

organizational." Both issues gave rise to extensions and reconceptualizations regarding the definition, the antecedents, dimensions and outcomes of absorptive capacity.

As the definition of absorptive capacity makes clear, absorptive capacity is a multilevel construct. The lowest level to apply absorptive capacity is *the individual level*. It is at this level that the link between absorptive capacity and learning is most evident. In this connection, Cohen & Levinthal (1990) refer to memory development, in which accumulated prior knowledge enables the ability to store new knowledge into one's memory and to recall and use it. This dynamic process gives rise to a key notion of absorptive capacity that prior related knowledge facilitates the learning or absorption of new related knowledge. Based on a review of the literature on learning and problem-solving processes at the individual level, Cohen & Levinthal (1990:130) suggest that both these processes develop similarly: "the prior possession of relevant knowledge and skill is what gives rise to creativity…" and that these processes require time and an intensity of effort. A final observation at the individual level about learning or the absorption of new related knowledge is that the diversity or breadth of knowledge domains is important. In this connection Cohen & Levinthal (1990:131) point out: "… knowledge diversity also facilitates the innovative process by enabling the individual to make novel associations and linkages."

Having founded the absorptive capacity construct at the individual level, the next level of analysis discussed by Cohen & Levinthal (1990) is *the organizational level*. Simply adding the absorptive capacity of the organizational members, however, will not give rise to the absorptive capacity at organizational level. What is missing in such a naïve approach is to pay attention to the (organizational) context, or as Cohen & Levinthal (1990:131) point out (italics added): "… it is therefore useful to consider *what aspects of absorptive capacity are distinctly organizational*."

Although Cohen & Levinthal (1990) primarily focus on absorptive capacity at the firm level, several observations are made regarding *the interfirm level*. For example, critical remarks are made regarding a firm "buying" absorptive capacity through hiring new personnel or corporate acquisitions. The path dependent and often tacit nature of a firm's idiosyncratic prior related knowledge and organizational context limits the quick integration of outside acquired absorptive capacity. Referring to the definition of absorptive capacity, considerable efforts and time are involved to assimilate and apply to commercial ends these types of external knowledge. Another observation deals with cooperative research ventures or strategic alliances emphasizing: "the simple notion that it is important to consider the costs of assimilating and exploiting knowledge from such ventures…" (Cohen & Levinthal, 1990:149). This notion stresses the importance of absorptive capacity of the partners involved in interorganizational relations. This has been elaborated in subsequent research, in for example the relative absorptive capacity construct (Lane & Lubatkin, 1998).

Having touched upon the individual, firm and interorganizational levels of analysis it is important to point out the multilevelness characteristic of absorptive capacity, like Cohen & Levinthal (1990:128, italics added) do: "Outside sources of knowledge are often critical to the innovation process, *whatever the organizational level at which the innovating unit is defined*". Therefore, other relevant levels of analysis are a particular industry, cluster of related industries, such as an emerging industrial complex (such as multimedia (De Boer et al., 1999) and financial services (Volberda et al., 2001)), region or nation (Wegloop, 1995) or even clusters of institutionally linked countries, like the European Union (Meyer-Krahmer and Reger, 1999).

Key antecedents and organizational outcomes

Cohen & Levinthal (1990) describe prior related knowledge as various related knowledge domains, basic skills and problem solving methods, prior learning experience and learning skills, and a shared language. This encompassing view on prior related knowledge means that this construct relates to a cluster of antecedents of absorptive capacity. Several of these examples, like learning experience, problem-solving methods and in particular a shared language, however, refer directly to the "distinctive organizational aspects" of absorptive capacity. We will label these aspects as "*internal mechanisms* that influence the organization's absorptive capacity" (Cohen and Levinthal, 1990:135, italics added) giving rise to a second cluster of antecedents. We suggest, therefore, to consider *two clusters of antecedents*: (1) prior related knowledge and (2) internal mechanisms, namely distinctly organizational aspects of absorptive capacity. Figure 2 depicts both clusters of antecedents and the partial overlap of these clusters. For instance, in each cluster the importance of shared language is mentioned. Furthermore, as Cohen & Levinthal (1990:132) also have emphasized, the internal mechanisms discerned in Figure 2 are mutually related: "… designing communication structures cannot be disentangled from the distribution of expertise in the organization."

[Insert Figure 2 about here]

The distinction of two key clusters of antecedents of absorptive capacity makes several developments in the literature clear. First, as these two clusters of antecedents of absorptive capacity address rather encompassing phenomena, scholars working with the absorptive capacity construct will tend to select a subset of the antecedents from one or from both

clusters as depicted in Figure 2. In empirical research, this selection of a subset of antecedents will be influenced in particular by the availability of data. In a more general sense, theoretical and/or empirically driven selection processes regarding antecedents and outcomes to be addressed in research gave rise to several absorptive capacity models. Second, considering the broad and important organizational phenomena covered by the two clusters of antecedents, the absorptive capacity construct could in principle be used to integrate research regarding these phenomena. We will come back to this issue in the final section.

To understand the importance and usefulness of the absorptive capacity construct, besides the definition and antecedents, paying attention to the consequences of organizational outcomes is helpful as well. Cohen and Levinthal (1990) related absorptive capacity to organizational outcomes such as innovative capabilities and innovative performance. Furthermore, they pointed out that absorptive capacity affects expectation formation "… permitting the firm to predict more accurately the nature and commercial potential of technological advances." (Cohen & Levinthal, 1990:136). Related to expectation formation is the impact the level of absorptive capacity may have on a firm's aspiration level as organizational outcome. In this connection Cohen and Levinthal (1990:137) suggest that the higher the level of absorptive capacity, the more likely a firm will be proactive in "… exploiting opportunities present in the environment, independent of current performance." Obviously, this type of organizational outcome is of great importance in, among others, strategy research, coevolutionary research and entrepreneurship research. We expect, therefore, that in these fields of inquiry the absorptive capacity construct will be used.

The absorptive capacity construct as mediator between related literatures

Figure 3 provides a brief overview of the various related literatures that could be bridged and enriched by using the absorptive capacity construct. The selection of these literatures is based on assessing to what extent these literatures are directly related to either the key antecedents of absorptive capacity and/or to the organizational outcomes associated with this construct. For several of the literatures mentioned in Figure 3 we will briefly illustrate these links. The link between absorptive capacity and the organizational learning and innovation literatures can be illustrated by referring to for example the dual role of R&D. R&D generates both innovations and new knowledge, but also enhances learning. This phenomenon is illustrated by the title of Cohen & Levinthal (1989) paper: "Innovation and learning: the two faces of R&D". Another example is provided by Cockburn and Henderson (1998) who pointed out that firms have to invest in absorptive capacity in the form of in-house basic research, to be able to access and learn from upstream basic research.

[Insert Figure 3 about here]

An example of a link between the organizational learning and managerial cognition literatures is among others provided by Dijksterhuis et al. (1999) who emphasize that a change in shared managerial schemas, that is a firm's idiosyncratic application of a single or multiple management logic(s), being shared among a firm's key decision makers, influence a firm's absorptive capacity. Examples of management logics are a classical and a modern management logic (Volberda, 1998). In a classical management logic, the environment is considered as a closed system while in a modern management logic, an open systems approach is used. Obviously, firms associated with a classical management logic do not

consider the environment as a source of valuable knowledge to be absorbed and, therefore, lack absorptive capacity.

Another example of how absorptive capacity might link several of the literatures mentioned in Figure 3, is provided by research on strategic renewal. Strategic renewal can take place by external actions like strategic alliances aimed at creating an organizational competitive advantage in which the absorptive capacities of the firm involved are important (Dyer and Singh, 1998). Internal actions, like starting up new businesses and launching new products and services, require substantial exploration activities and an absorptive capacity to facilitate these activities (Volberda et al., 2001). In coevolutionary research, absorptive capacity is considered as one of the main mediating factors between micro- and macro evolution (Lewin et al., 1999). For an overview of knowledge and internal, external and social networks including the relationship with absorptive capacity see Van Wijk et al. (2002).

3. Absorptive capacity: refinements, extensions and reconceptualizations

We will discuss briefly here illustrative research that extends the definition and levels of analysis of absorptive capacity. Next, we elaborate the dimensions of absorptive capacity discerned in subsequent research and we will illustrate how the required dimensions at firm level depend on the external context.

Definitions and levels of analysis: extensions

The lowest level of analysis of absorptive capacity within a *focal firm* is the individual level. Examples of intermediate levels are the team, organizational unit, business unit, division and

subsidiaries within multidivisional enterprises. Finally at the corporate level the focal firm's absorptive capacity may be assessed. Of these levels of analysis, the majority of the publications on absorptive capacity address either the business unit level (for example Tsai, 2001) or the subsidiary level (for instance Gupta & Govindarajan, 2000), but in particular the firm level (for instance Pennings and Harrianto 1992). Several scholars analyzing the absorptive capacity of a focal firm, however, emphasize different aspects of Cohen& Levinthal's (1990) definition and adopt these aspects to the appropriate level of analysis or add new aspects as well. For example, Kim (1998) focused on learning capability and problem-solving skills, being part of prior related knowledge as the first cluster of antecedents (see Figure 2), and analyzes absorptive capacity at the firm level by investigating prior knowledge bases and the intensity of effort. Gupta and Govindarajan (2000) analyzed the absorptive capacity of subsidiaries in multinational enterprises by focusing on the prior related knowledge of these organizational units.

Research on absorptive capacity in an *interorganizational context* such as strategic alliances and joint ventures have been performed by for example Inkpen and Dinur (1998), Lyles & Salk (1996), and Kamien and Zang (2000); see Van Wijk et al. (2002) for an overview. Lane & Lubatkin (1998) reconceptualized the firm level definition of Cohen & Levinthal (1990) and suggested the construct of *relative absorptive capacity*. Relative absorptive capacity is defined as "the ability of a firm to learn from another firm" in a student-teacher pairing, namely a learning dyad (Lane & Lubatkin, 1998:462). Relative absorptive capacity is, like in Cohen & Levinthal's definition of absorptive capacity, dependent on "the ability of the student firm to recognize and value new external knowledge, to assimilate that knowledge, and to commercially utilize it." (Lane & Lubatkin, 1998:464). The importance of considering the absorptive capacity of the partner in interorganizational relations has been pointed earlier

by for instance Veugelers and Kesteloot (1996). They investigated, among others, asymmetries in absorptive capacity between partners and the likelihood of establishing successful R&D joint ventures.

In the context of national systems of innovations (NSI), research on the level of analysis of the absorptive capacity of *nations* has also been conducted. For example Carlsson and Jacobsson (1994) investigated technological systems in Sweden. They pointed out that increasing the absorptive capacity of the economy becomes an important aspect of public policy. Another interesting example is provided by Wegloop (1995:419) who suggested to distinguish National Absorptive Capacity defined as "those institutions and actions that allow firms within the NSI to recognize the value of new external information, assimilate it, and apply it to commercial ends." Keller (1996) investigated a country's implementation of technologies invented abroad and mentions the importance of raising the absorptive capacity of the economy. See also Mowery and Oxley (1995) and Montresor (2001) on related topics and Meyer-Krahmer and Reger (1999), who discussed the importance of raising the absorptive capacity of national systems of innovations in a European context.

Dimensions of absorptive capacity: extensions

Several authors have pointed out that absorptive capacity is a multidimensional construct. Based on Cohen & Levinthal's (1990) definition of absorptive capacity and the distinction of three types of abilities, below we will provide some examples. Lane & Lubatkin (1998) suggested to distinguish three dimensions: (1) the ability to recognize and value new external knowledge, (2) the ability to assimilate new external knowledge and (3) the ability to commercialize new external knowledge. Based on Grant (1996), who discussed three

dimensions of knowledge integration, Van den Bosch et al. (1999) suggested to distinguish similar dimensions of knowledge absorption: respectively the *efficiency*, *scope* and *flexibility dimension*. Van Wijk et al. (2001) highlighted the depth and breadth dimension of absorptive capacity. The *depth dimension* of absorptive capacity facilitates the absorption of new, additional knowledge in a domain in which knowledge is already present. Deep knowledge gains from specialization. Specialization enhances rationalization and routinization. The depth of absorptive capacity is, therefore, associated with the efficiency dimension of knowledge absorption. The *breadth dimension* of absorptive capacity enables the absorption of new knowledge in domains other than but related to what is currently known. This dimension is associated with the scope dimension of knowledge absorption and with exploration. Zahra and George (2001) suggested distinguishing four dimensions of absorptive capacity, each playing different but complementary roles in explaining how absorptive capacity can influence organizational outcomes. These *four dimensions* are respectively: the acquisition, assimilation, transformation and exploitation dimension. Zahra and George (2001) relate these dimensions to corresponding capabilities. To emphasize the contingent character of the relevance of the dimensions of absorptive capacity, below we will illustrate how a particular type of external knowledge environment may influence the required dimensions of absorptive capacity.

Dimensions of absorptive capacity and changing external contexts

As indicated above, building on Grant's (1996) three characteristics of knowledge integration, Van den Bosch et al. (1999) distinguished three dimensions of knowledge absorption: efficiency, scope and flexibility. Efficiency of knowledge absorption refers to the activities, procedures and routines that firms use to identify, assimilate and exploit new

knowledge. The efficiency dimension focuses on the cost and economies of scale perspective on knowledge absorption. The scope dimension of knowledge absorption is associated with the breadth of knowledge a firm draws upon. Flexibility of knowledge absorption refers to the extent to which a firm can access additional, and reconfigure existing knowledge. March's (1991) distinction between exploration and exploitation in the development of organization knowledge can be related to these three dimensions of knowledge absorption. The efficiency dimension of knowledge absorption is associated with the exploitation of a firm's knowledge configuration, as "the essence of exploitation is the refinement and extension of existing competencies, technologies, and paradigms." (March, 1991:85). Furthermore, the scope and flexibility dimension of knowledge absorption can be associated with the exploration of a firm's knowledge configuration.

How do firms cope with the peculiarities of their (knowledge) environment? This question has been raised earlier by Starbuck (1992). In the following application based on Van den Bosch et al. (1999), we elaborate on this question by investigating how *key contingencies in the external knowledge environment* do influence the required presence or absence of the dimensions of knowledge absorption. We will distinguish two contingencies: a stable and a turbulent knowledge environment, see Figure 4. In a stable knowledge environment, like a mature single industry, existing firms have a strong focus on the exploitation of knowledge. The knowledge domain the incumbent firm wishes to exploit is closely related to its current knowledge base (Cohen and Levinthal, 1990). This phenomenon is associated with "local search", for instance when a firm's R&D activity is closely related to it previous R&D activity (Huygens at al., 2001).

[Insert Figure 4 about here]

Within the context of exploitation of knowledge, a firm's interface function- capturing the structure of communication between the external environment and the firm and between subunits within the firm and being one of the antecedents of absorptive capacity- will have a tendency to become more centralized, increasing the efficiency of internal communication. Following Cohen and Levinthal (1990), we point out that this centralization tendency is supported by a well-developed shared knowledge and an internal language, creating a more inward-looking absorptive capacity. Cohen and Levinthal (1990:133) pointed out that both inward-looking and outward-looking absorptive capacities are necessary for effective organization, but that "… excessive dominance by one or the other will be dysfunctional." Over time, an efficiency focus on knowledge absorption is likely to result in a low diversity of knowledge structures, few cross-functional relationships and a low absorptive capacity. Firms operating in stable knowledge environments, therefore, are likely to become more reactive. This reactive firm behavior can be considered as an example of an organizational outcome moderated by absorptive capacity.

Contrary to firms in stable knowledge environments, firms in turbulent knowledge environments, however, are likely to dedicate efforts exclusively to increasing their absorptive capacity. In such environments, a firm's knowledge absorption is likely to be more focused on exploration. The scope and flexibility dimension of knowledge absorption are important in such a context. Contrary to the situation in a stable knowledge environment, the interface function is likely to be more decentralized in a turbulent knowledge environment. This decentralization of the interface function is reflected in an increasing diversity or breadth of knowledge structures and a growing importance of cross-functional relations, (Jones and Craven, 2001). Figure 4 summarizes the impact these different knowledge

environments are likely to have on the requirements regarding the three dimensions of knowledge absorption. Another example of how the required dimensions of absorptive capacity are influenced by the external environment is provided by Zahra & George (2001), who discuss the impact of various appropriability regimes on their acquisition dimension of absorptive capacity. They suggest that when a firm is confronted with a weak regime of appropriability, the acquisition of new external knowledge will be low because imitation of innovative products or services by rivals might be the case.

Antecedents and organizational outcomes: extensions

In the previous section we suggested that scholars are likely to focus on a particular subset of antecedents selected from the two clusters of antecedents discerned in Figure 2. Furthermore, depending on the level of analysis, particular variables within these two clusters are likely to be selected or refined. Figure 5 illustrates this selection process by providing a brief overview of the types of antecedents used at various levels of analysis. At the intrafirm level the antecedents used in the three examples provided in Figure 5 address different selections from the two clusters of antecedents Tsai (2001) selected a content dimension of prior related knowledge by using R&D expenditure (divided by sales). For a more encompassing approach of prior related knowledge see for example Shane (2000). In the other two examples an operationalization is used of both prior related knowledge and a subset of internal mechanisms influencing the unit's absorptive capacity. Van Wijk et al. (2001) used the knowledge flow configuration as antecedent addressing general knowledge and prior learning experience. The knowledge flow configuration also reflects the character and distribution of expertise and knowledge (Van Wijk et al., 1998, 2000). The knowledge flow configuration addresses, therefore, parts of the two clusters of antecedents of absorptive capacity as

depicted in figure 2. Furthermore, in the survey used the structure of the communication, another internal mechanism influencing absorptive capacity mentioned in Figure 2, is addressed as well.

[Insert Figure 5 about here]

Gupta and Govindarajan (2000) used Cohen & Levinthal (1990)'s definition to operationalize the antecedents of absorptive capacity of subsidiaries of multinational enterprises, see Figure 5. The antecedents used at firm level in Van den Bosch et al. (1999) and Zahra and George (2001) will be discussed in the section on absorptive capacity models below. At interfirm level Lane and Lubatkin (1998) used three antecedents for explaining the relative absorptive capacity construct. These *interorganizational antecedents* are the similarity of both firms' knowledge bases (but different specialized knowledge), organizational structures and compensation policies, and dominant logics. The first antecedent refers to the relative relationship between the student firm's knowledge and that of its teacher. Regarding the second antecedent, both organizational structures and compensation policies serve as proxies for the similarity of the knowledge-processing systems and norms of the firms involved. The third antecedent is based on the assumption that a firm's dominant logic determines why it applies the acquired knowledge to which commercial objectives. These three antecedents refer to respectively the know-what, know-how and know-why portion of the knowledge bases involved. Their dependent variable is a firm's success regarding interorganizational learning.

Organizational outcomes

Many scholars recognize that a firm's absorptive capacity is not a goal in itself, but that it moderates important organizational outcomes. For example, Cohen and Levinthal (1990) relate absorptive capacity to, among others, innovative capabilities, innovative performance and expectation formation. In subsequent research efforts several related organizational outcomes have been addressed. In Figure 6 we give some examples of organizational outcomes and illustrative references.

[Insert Figure 6 about here]

For three examples in Figure 6 we will briefly discuss how absorptive capacity influences the organizational outcome. Van Wijk et al. (2001) found that vertical knowledge transfers appeared to relate to increases in the depth dimension of absorptive capacity but have no significant relation with the degree of exploration over exploitation. Horizontal knowledge transfers were found to have a positive relationship with the breadth dimension of absorptive capacity. The breadth of absorptive capacity appeared to be positively related to the level of exploration over exploitation. Stock et al. (2001) investigated the influence of absorptive capacity (operationalized by R&D intensity) and new product development performance in the computer modem industry. Their results indicated an "inverted-U" shape, suggesting increasing absorptive capacity results in increasing performance but only up to a certain level. Deeds (2001) studied the relationship between absorptive capacity and the amount of entrepreneurial wealth creation using as a proxy for absorptive capacity, the aggregate number of research communities in which a firm participates measured by co-citation analysis. The results indicated a positive relationship between absorptive capacity and entrepreneurial wealth creation in pharmaceutical biotechnology firms in the USA.

4. Absorptive capacity models

To enhance the development of absorptive capacity models, we will emphasize the importance of considering models both as mediators between theories and the real world and as learning mechanisms. To this end, we will discuss examples of absorptive capacity models each addressing different antecedents, outcomes and levels of analysis.

Models as mediators

Morgan and Morrison (1999) introduce the perspective of viewing models as mediators or mediating instruments between theory and empirical phenomena. In this perspective, models are considered as "autonomous agents" that can function as an instrument of investigation. In this connection, Morgan and Morrisson (1999:10) point out: "It is precisely because models are partially independent of both theories and the world that they have this autonomous component and so can be used as instruments of exploration in both domains." In elaborating this perspective they address *four questions*. These questions deal with respectively: how models are constructed, how models function, what models represent and finally how we can learn from models. Morgan and Morrison (1999:11-12) emphasize that: "We do not learn much from looking at a model – we learn more from building the model and from manipulating it." Learning from building models stimulates finding out what "will work to represent certain aspects of the theory or the world or both." (Morgan and Morrison, 1999:386). Below, three recent efforts in model building will be discussed as illustrative examples. These three models all address antecedents and organizational outcomes of absorptive capacity, albeit by focusing on different subsets of antecedents (in terms of Figure 2) and dimensions and on particular outcomes (in terms of Figure 6). The models also differ

regarding empirical research methodology. The first model is illustrated in longitudinal case research, the second model is advanced as a conceptual model while the third model is tested in quantitative research.

Illustrative examples of absorptive capacity models

Figure 7 portrays a model of absorptive capacity distinguishing major antecedents and outcomes that are closely related to the ones discerned by Cohen & Levinthal (1990). The model depicts how absorptive capacity is largely a function of prior related knowledge and how two complementary antecedents reflect key examples of "internal mechanisms influencing a firm's absorptive capacity" as described in Figure 2. The model portrays how these two internal mechanisms moderate prior related knowledge and absorptive capacity. In the context of this model, prior related knowledge can be considered as a kind of distributed organizational knowledge system (Tsoukas, 1996), while the two internal mechanisms enable the connection and integration of the various parts, domains and skills of prior related knowledge. These two internal mechanisms emphasize the fundamentally organizational character of a firm's knowledge (Zollo and Winter, 2001).

This way of modeling suggests that, for example, ceteris paribus prior related knowledge, a change in organizational form for example from a functional to a matrix form (Volberda, 1998), or from a functional form to internal network forms of organizing (Van Wijk et al., 2002), has an influence on the level of absorptive capacity. The third antecedent refers to combinative capabilities. This construct is used in the model to investigate the capabilities associated with the internal mechanisms influencing a firm's absorptive capacity. A firm's combinative capabilities synthesize and apply current and acquired knowledge (Kogut and

Zander, 1992). The use of the term "combination" by Kogut and Zander is associated with "integration," as used by Grant (1996). Van den Bosch et al. (1999) build on these contributions by distinguishing between three types of combinative capabilities a firm has at its disposal: systems capabilities, coordination capabilities, and socialization capabilities. Systems capabilities refer to procedures and manuals often used to integrate explicit knowledge. Coordination capabilities enhance knowledge absorption through relations between members of a team, an organization unit or organization units; for an interesting account of team learning and the role of team leader coaching see Edmondson (2001). Socialization capabilities refer to a shared ideology as well as collective interpretation of the reality and enable absorptive capacity by specifying broad, tacitly understood rules for appropriate action under unspecific contingencies (Camerer and Vepsalainen, 1988).

In using the combinative capability construct, both the structure of communication and the distribution of expertise and knowledge - representing the second cluster of antecedents - are introduced in the model. Systems,- coordination- and socialization capabilities address several aspects of the structure of communication and the ways in which the distribution of expertise and knowledge are involved in knowledge absorption. For example, systems capabilities enable the combination of explicit knowledge available within the distribution of knowledge across the organizational units, while coordination and socialization capabilities enable the externalization of tacit knowledge. In this regard, Jones and Craven (2001) provide empirical evidence how in particular coordination capabilities can positively influence a firm's absorptive capacity. The model depicts two related types of organizational outcomes: expectation formulation and the exploitation/exploration path. Both outcomes contribute to the path dependent character of absorptive capacity, giving rise to dynamic effects such as a

feedback loop from the level of expectation formation to a change in organizational form, enhancing the absorptive capacity.

[Insert Figure 7 about here]

The model sketched above has been illustrated by two longitudinal case studies (Van den Bosch et al., 1999). The primary purpose of these case studies is obtaining insights into how the firms' absorptive capacity, at the time of transformation of the industry from traditional publishing firms moving into the emerging multimedia industrial complex, moderated and coevolved with the firms' adaptations in organizational form and combinative capabilities. The case studies illustrated how the organizational form and combinative capabilities interact over time and what their combined effect was on the level of absorptive capacity. The case studies also highlighted the stickiness of socialization capabilities and the struggle with changing organizational forms, aimed at forms that facilitate the scope and flexibility dimension of knowledge absorption.

A second example of absorptive capacity model

Figure 8 portrays another example of a model of absorptive capacity at firm level, in which the distinction between a firm's *potential* and *realized capacity* to absorb knowledge is introduced. Potential capacity comprises knowledge acquisition and assimilation, while realized capacity is determined by transformation and exploitation. In this connection Zahra and George (2001:3) point out that outcomes reflect a firm's realized capacity and that the potential capacity component "has received disproportionally less empirical scrutiny when compared to realized capacity." They suggest both types of capabilities have separate, but

complementary roles and propose to take into account *the efficiency factor*: the ratio of realized to potential absorptive capacity. Firms with a high efficiency factor are likely to increase their performance.

[Insert Figure 8 about here]

Zahra and George (2001) distinguish as key antecedents external sources of knowledge, such as inter-organizational relationships like alliances, knowledge complementarity and experience. External sources of knowledge must be complementary to the knowledge a firm already possesses. In comparison to the two clusters of antecedents depicted in Figure 2, in this model the antecedents do not address the second cluster of antecedents being the internal mechanisms influencing a firm's absorptive capacity. Instead, internal (for example an organizational crisis) and external (for example regulatory change) triggers are introduced, moderating the antecedents, potential and realized absorptive capacity and outcomes. In the model, so-called social integration mechanisms are supposed to reduce the gap between potential and realized absorptive capacity and thereby increase the efficiency factor. Both informal and formal social integration are discerned. These mechanisms are expected to lower the barriers to information sharing and are, therefore, related to one of the key antecedents, being structure of communication, discerned in Figure 2. The model explicitly takes into account the external context to explain the relationship between absorptive capacity and outcomes by introducing the regimes of appropriability as moderating factor. Under a strong regime of appropriability it is expected that there will be a significant and positive relationship between realized absorptive capacity and sustainable competitive advantage as outcome, because of higher costs of imitation by rivals. Zahra and George (2001) advanced the above sketched conceptual model but did not test the model.

A third example of absorptive capacity model

Figure 9 portrays an absorptive capacity model (Lane et al., 2001) of learning in international joint ventures (IJV) from knowledge held by foreign parents. The model segments absorptive capacity into the three types of capabilities proposed by Cohen & Levinthal (1990). The first two capabilities enable knowledge learned from foreign partners, while the third is directly associated with the realization of organizational outcome and is, therefore, in a sense related to realized absorptive capacity discussed in the previous model. In this model, the antecedents are distributed along each of the three components of absorptive capacity. The antecedents of the first component are trust between an IJV's parents and the IJV's relative absorptive capacity vis-à-vis its foreign parent. The second component, the ability to assimilate new knowledge from the parents, is determined by an IJV's flexibility and in particular its learning structure and processes (Lyles and Salk, 1996). The IJV's strategy and training competences (in particular relevant for tacit knowledge) are the antecedents of the third component. By segmenting the model in this way, the relationship between the first two components and IJV performance is moderated by the amount of knowledge learned from the foreign parents. The model was tested in a sample of established Hungarian IJV's surveyed in 1993 and again in 1996. The results provide support for the above indicated antecedents of each of the three components. The results, however, suggest that of the three components of absorptive capacity, the antecedents of the first two, do affect learning but not performance. The antecedents of the third component, the ability to apply external knowledge, however, do influence performance.

[Insert Figure 9 about here]

Learning from modeling absorptive capacity

In reflecting on the three examples of models of absorptive capacity, we briefly address the questions raised by Morgan and Morrison (1999). Regarding the first question how the models are constructed, the three examples above show that the construction process can be triggered by the absorptive capacity theory or associated theories and/ or by the empirical problems addressed by the model. All these examples, however, incorporated a subset of antecedents and dimensions or components of absorptive capacity in the model, and a particular organizational outcome as well. The selection of the subset of antecedents of absorptive capacity chosen or of its components is, however, not extensively discussed or justified in these three examples. In addressing the second question, this suggests that the three models function partly to illustrate absorptive capacity theories, partly to address the selected organization outcomes and partly to integrate and reconceptualize previous modeling efforts and empirical findings. Reflecting on the third question about what the models represent, this variety in functions of the models discussed emphasizes that these models represent neither absorptive capacity theories nor empirical realities. Indeed, these models try to mediate both.

How can we learn from these modeling efforts? First, it seems important in ongoing research efforts to recognize the mediating role of absorptive capacity models. Second, to learn from the various ways in which this role can be performed, it is important to justify more clearly what theoretical and empirical aspects are selected and how they are addressed in the proposed model. Third, as absorptive capacity, due to its cumulative and path dependent character, by definition requires a dynamic model, in further model building efforts this issue

deserves serious attention. Although progress has been made in conceptual absorptive capacity models, in most empirical research there is less or no room for assessing for example how changes in antecedents influence absorptive capacity over time, including feedback loops such as how an increase of absorptive capacity may influence internal organizational factors (Van den Bosch et al., 1999). Fourth, considering the multilevel and transdisciplinary character of the absorptive capacity construct, in papers using absorptive capacity models it is important to discuss the contribution of the proposed model to (1) addressing the multilevel characteristic and (2) to what extend the model might help bridging and enriching which literatures.

5. Progress, problems and future research directions

To benefit from the templates used in the preceding sections, in the first column of Figure 10 we discern important conceptual attributes and characteristics of absorptive capacity. Figure 10 contains three columns in which we *tentatively indicate the progress*, select some problems and topics for future research. In doing so, we hope to contribute to the purpose of this chapter as indicated in the introduction.

[Insert Figure 10 about here]

Progress and problems

In our assessment of the progress of the development of the absorptive capacity construct, models and applications, *two observations* are evident. First, considering the relatively large number of publications on absorptive capacity dealing with a variety of levels of analysis, the

multilevelness characteristic of absorptive capacity has clearly been recognized by researchers in various related fields of inquiry. Second, in literature search using different search programs, it is amazing to observe the variety of journals associated with different literatures (see for example the references) publishing papers on absorptive capacity using this construct as either independent variable or dependent variable. In the context of the analysis in the preceding sections, these two observations give rise to our *third observation*. The proliferation of models and applications of the absorptive capacity construct to various levels of analysis and in various related literatures did not substantially contribute yet to cumulative learning and scientific knowledge accumulation about the theoretical and empirical underpinnings of the absorptive capacity construct. To the extend this third observation is correct, this *gap* between the speed of proliferation of theoretical and empirical *applications* and the speed of *accumulation of the acquired scientific knowledge* might weaken over time the multilevel and transdisciplinary characteristics of absorptive capacity. In an effort to narrow this gap we will first discuss the progress made and select problems regarding the conceptual attributes.

Although the definition of absorptive capacity is generally speaking not disputed in the literature, its contribution to the measurement of absorptive capacity appears to be more problematic in the sense that for the measurement of the absorptive capacity construct its antecedents are often used. For example, in empirical research R&D spending as a percentage of sales is often used as a proxy for a firm's absorptive capacity. But R&D is also a part of the antecedent prior related knowledge (see Figure 2). As Mowery et al. (1996:82) pointed out: "R&D intensity measures inputs to the creation of capabilities and indicates little if anything about resultant changes in capabilities." Lane and Lubatkin (1998) provided empirical evidence about the relatively low explanatory power of R&D spending in

comparison to the explanatory power of their three dimensions of absorptive capacity. We believe these problems gave rise to efforts aimed at operationalizing the dimensions or components of absorptive capacity (see section 3). These efforts resulted in for example distinguishing complementary dimension like potential and realized capacity (Zahra and George, 2001) and in empirically assessing separate dimensions or abilities to absorb external knowledge in empirical research. For example the findings of Lane et al. (2001) suggest that the first two components of absorptive capacity, being the ability to recognize and the ability to assimilate new external knowledge, affect learning while the third component, the ability to apply new external knowledge, did not influence learning but affect performance.

The progress made regarding operationalizing the antecedents and determining their impact on absorptive capacity is in our view not substantial. At intraorganizational and firm level, the internal mechanisms influencing absorptive capacity still deserve attention in terms of assessing their impact on absorptive capacity. At interorganizational level, however, substantial progress has been made by the introduction of the relative absorptive capacity construct (Lane and Lubatkin, 1998), the measurement of this construct by expert evaluations and the empirical assessment of the influence of the antecedents. The relationships between the antecedents at firm level and at dyad or interorganizational levels still deserve attention. A systematic account of antecedents of absorptive capacity beyond the dyad, for example at national level, is up till now missing. The progress made pertaining to the organizational outcomes of absorptive capacity can be discussed along two lines: the number of various types of outcomes discerned and the empirical evidence found to the extend absorptive capacity indeed contributes to these outcomes. As already discussed above, see also Figure 6, absorptive capacity is expected to moderate a large number of organizational outcomes. The

empirical assessment to what extend this is the case and taking into account which kinds of contingencies, has made some progress.

In discussing the progress, we pointed out our third observation: the gap between the speed of proliferation of theoretical and empirical applications and the speed of accumulation of the acquired scientific knowledge about absorptive capacity. The problems we have selected in the third column of Figure 10 have in common that we perceive them as important *barriers* to the accumulation of scientific knowledge. The first issue mentioned in Figure 10 deals with the definition and measurement of the construct. The definition provided by Cohen and Levinthal (1990) discerns three types of abilities constituting the absorptive capacity construct. In empirical research some researchers focus on trying to measure the construct on the basis of company data or by evaluations by outsiders, or instead of the construct measuring the associated outcome, while other researchers focus on the three abilities. There is no general agreement, therefore, how to measure absorptive capacity. The antecedents of absorptive capacity at the various levels of analysis and in particular how they are related to each other is still another serious problem. For example, how are the absorptive capacities of employees related to a firm's absorptive capacity? As discussed above, internal organizational mechanisms operationalized by for example the type of organizational form and combinative capabilities in use (Van den Bosch et al., 1999) do play a role, but to what extend is this the case for other levels of analysis as well? And how are organizational antecedents related to interorganizational antecedents? Is the relationship between independent and dependent variables similar at different levels of analysis (Rousseau, 1985)? These questions address the issue of multilevel research (Klein et al., 1994, 1999; Morgeson and Hofman, 1999). Another barrier is the lack of attention regarding the question what can we learn from absorptive capacity model building efforts. Investigating these problems is in

particular important for the underpinning of absorptive capacity as a multilevel and transdisciplinary construct.

Future research directions

Building on the discussions of the progress and problems, we selected four promising future research directions, see the fourth column of Figure 10. In terms of research priorities, more emphasis on construct development and measurement and on model building is mostly needed. Hopefully, these efforts will enable the third future research direction, the emergence of multilevel theory building regarding absorptive capacity. These research directions will give rise to an even more fruitful bridging and enriching of related literatures. We will briefly elaborate each of these future research directions below.

In further developing the absorptive capacity construct, it seems useful to focus on how the various capabilities, dimensions or components discerned from absorptive capacity can be helpful for the operationalization and measurement of the construct. Regarding *measurement*, utilizing and comparing complementary methods are clearly needed. For example, by using a survey filled out by employees of the firm involved, but also by using a survey aimed at industry experts assessing the firm involved and/ or by using quantitative proxies and case study research. Reflecting on different measurement methods of absorptive capacity and by clearly distinguishing the measurement of the construct and the measurement of its antecedents and consequences will create further progress. The construct development will also be triggered by a strong emphasis on model building efforts as well. From the perspective of models as mediators between theories and empirical phenomena, complementary absorptive capacity models may highlight different aspects of the absorptive

capacity construct and stimulate the search for corresponding aspects of the empirical phenomena investigated.

The development of dynamic models is also needed. In particular the development of a coevolutionary research approach to explain the change in a firm's absorptive capacity (Lewin and Volberda, 1999). The incorporation of variables addressing *managerial intentionality* to influence the level of absorptive capacity is also needed. Therefore, paying attention to managerial cognition (Calori et al., 1994), managerial knowledge integration (Van den Bosch and Van Wijk, 2001) and managerial competences (Sanchez, 2001) will be important in future model building efforts. By juxtaposing both complementary models and their findings at various levels of analysis we can learn more about the absorptive capacity construct and its dimensions, the antecedents, outcomes and measurement methods as well. On the basis of these research efforts, it may become clear to what extend absorptive capacity models have the characteristics of multilevel models. In multilevel models "the relationship between the independent and dependent variables is generalizable across organizational entities" (Klein et al., 1994:223). In doing so, the multilevel and transdisciplinary characteristics of absorptive capacity might be further explored and developed.

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Figure 1: Issues addressed in this chapter

Section 2: Absorptive capacity construct: definition, antecedents and organizational outcomes

- Definitions and levels of analysis
- Key antecedents and organizational outcomes
- The absorptive capacity construct as mediator between related literatures

Section 3: Absorptive capacity: refinements, extensions and reconceptualizations

- Definitions and levels of analysis
- Dimensions of absorptive capacity
- Antecedents and outcomes

Section 4: Models of absorptive capacity: extensions

- Models as mediators
- Illustrative examples of absorptive capacity models
- Learning from modelling absorptive capacity

Section 5: Progress, problems and future research directions

- Progress and problems
- Future research directions

Figure 2: Two key clusters of antecedents of a firm's absorptive capacity

Prior related knowledge as the first cluster of antecedents	***Internal mechanisms influencing a firm's absorptive capacity as the second cluster of antecedents***
examples: · general knowledge of related domains · basic skills and problem solving methods · prior learning experience · shared language	· *structure of communication* (both intra- and interorganizational); examples: centralized versus decentralized interface functions, shared internal language etc. · *character and distribution of expertise and knowledge* within organization; examples: cross- function interfaces, internal and external networks etc.

Source: Based on Cohen & Levinthal (1990), see also Van den Bosch, Volberda, De Boer (1999), p.553

Figure 3: Examples of literatures the absorptive capacity construct might bridge and enrich

· Organizational learning literature

· Managerial cognition literature

· Innovation and national systems of innovation literature

· Organizational change, Strategic renewal and Entrepreneurship literature

· Knowledge-based view of the firm literature

· Dynamic capability theory literature

· Coevolutionary research literature

· Interorganizational relations and network literature

Source: authors

Figure 4: Types of Knowledge environments, Focus of Knowledge Absorption, and Requirements Regarding Three Dimensions of Knowledge Absorption

Types of Knowledge Environment:	Focus of Knowledge Absorption on:	Requirements Regarding Three Dimensions of Knowledge Absorption:		
		Efficiency	Scope	Flexibility
(1) Stable knowledge environment Example: Mature single industry	Exploitation	H	L	L
(2) Turbulent knowledge environment Example: Emerging industrial complex	Exploration	L	H	H

H: high; L: low

Source: Van den Bosch, Volberda and De Boer (1999)

Figure 5: Antecedents of absorptive capacity

Level of Analysis	***Examples of Antecedents***	***Illustrative References***
Intrafirm level	· a unit's R&D intensity	Tsai (2001)
	· knowledge flow configuration (horizontal versus vertical)	Van Wijk et al. (2001)
	· prior related knowledge and similarity of certain attributes (for example sharing similar common meanings, a mutual subcultural language)	Gupta and Govindarajan (2000)
Firm level	· prior related knowledge, and internal mechanisms (see Figure 2)	Cohen & Levinthal (1990)
	· prior related knowledge, organizational form, combinative capabilities	Van den Bosch et al. (1999)
	· external sources, knowledge complementarity and experience	Zahra & George (2001)
Interfirm level	· specific type of new knowledge; similarity of compensation practices and organizational structures; familiarity with organizational problems	Lane & Lubatkin (1998)

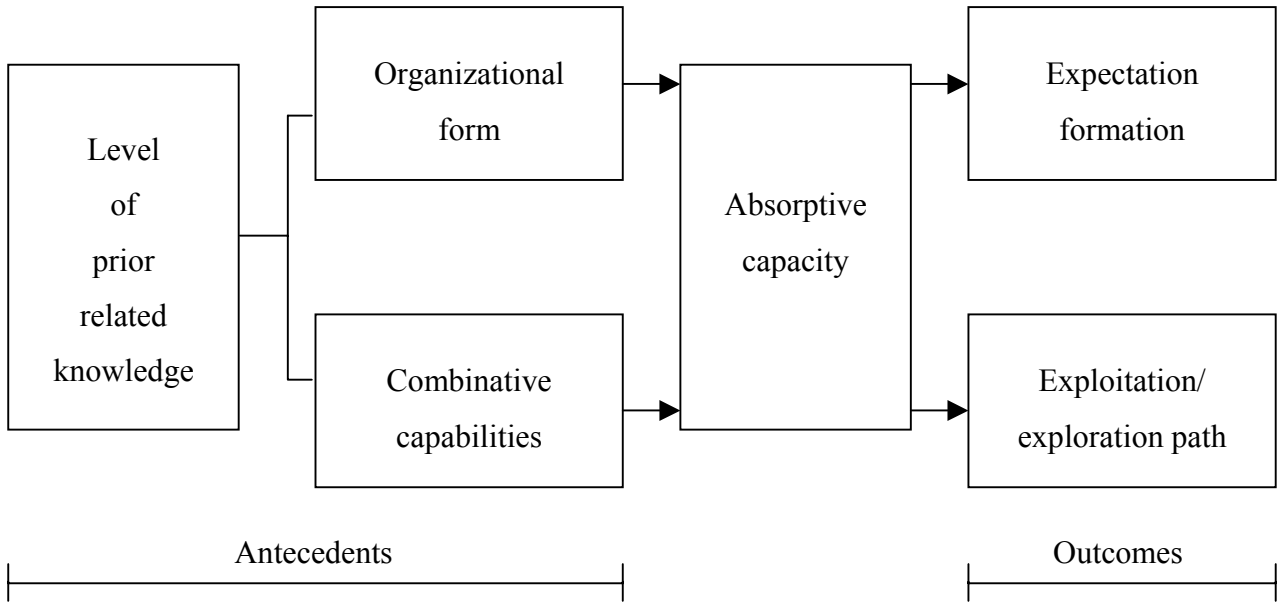
Source: authors

Figure 6: Absorptive capacity as moderator of various organizational outcomes

Examples of organizational outcomes	***Illustrative references***
· Innovative performance; exploration/ exploitation; new product development	Cohen & Levinthal (1990); Tsai (2001) Van Wijk et al. (2001) Stock et al. (2001)
· Expectation formation; reactive/ proactive strategy formation	Cohen & Levinthal (1990) Volberda (1998) Van den Bosch et al. (1999)
· Organizational adaptation; coevolution; strategic renewal	Lewin & Volberda (1999) Lewin et al. (1999) Volberda et al. (2001)
· Transfer of best practice and knowledge flows within the firm	Szulanski (1996) Gupta & Govindarajan (2000)
· New wealth creation; entrepreneurial wealth; competitive advantage; financial performance	Lewin et al. (1999) Deeds (2001) Zahra & George (2001) Tsai (2001)
· Knowledge transfers, organizational learning in alliances and IJV performance	Ahuja (2000); Kim (1998); Koza & Lewin (1998); Lane & Lubatkin (1998); Lyles & Salk (1996); Mowery et al. (1996)
· Diversification	Kumar & Seth (2001)

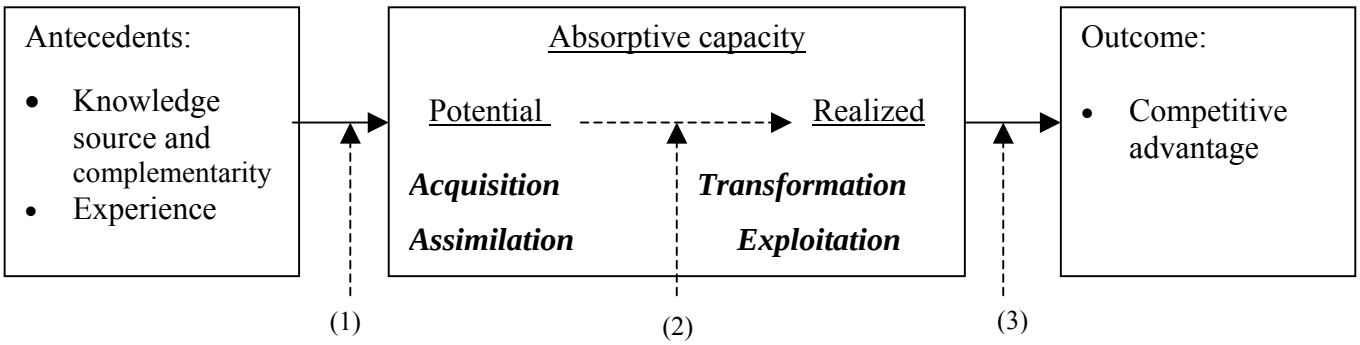
Source: authors

Figure 7: A model of a firm's absorptive capacity: antecedents and outcomes



Source: Adapted from Figure 1 in Van den Bosch, Volberda, De Boer (1999).

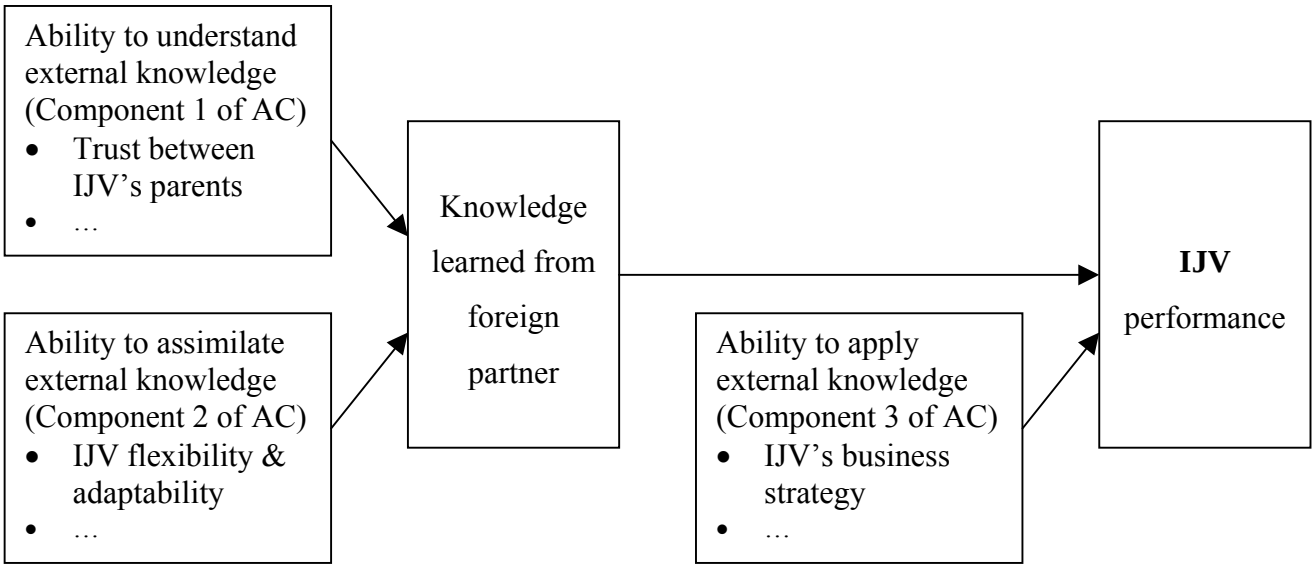
Figure 8: A model of a firm's absorptive capacity: antecedents and outcomes



(1): activation triggers (internal/external)
(2): social integration mechanisms
(3): regimes of appropriability

Source: Adapted from Figure 1 in Zahra and George (2001).

Figure 9: An absorptive capacity model of learning in international joint ventures (IJV): components, antecedents and outcome



Source: Adapted from Figure 1 in Lane, Salk and Lyles (2001)

Figure 10: Absorptive capacity: Progress, problems and future research

Absorptive capacity	*Progress*)*	*Problems: a selection*	*Future research directions*
• definition and measurement	±	√	construct development & measurement
• dimensions:	+		
• levels of analysis/ multilevel construct:	++		emphasis on multilevel theory
• intraorganizational antecedents		√	
- prior related knowledge	±		
- internal mechanisms	±		emphasis on model building
• interorganizational antecedents	+	√	
• outcomes:	+	√	
• models:	±	√	
• transdisciplinary construct:	++		bridging and enriching literatures

*) Progress: ++ (high); + (medium); ± (low)

Source: authors

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